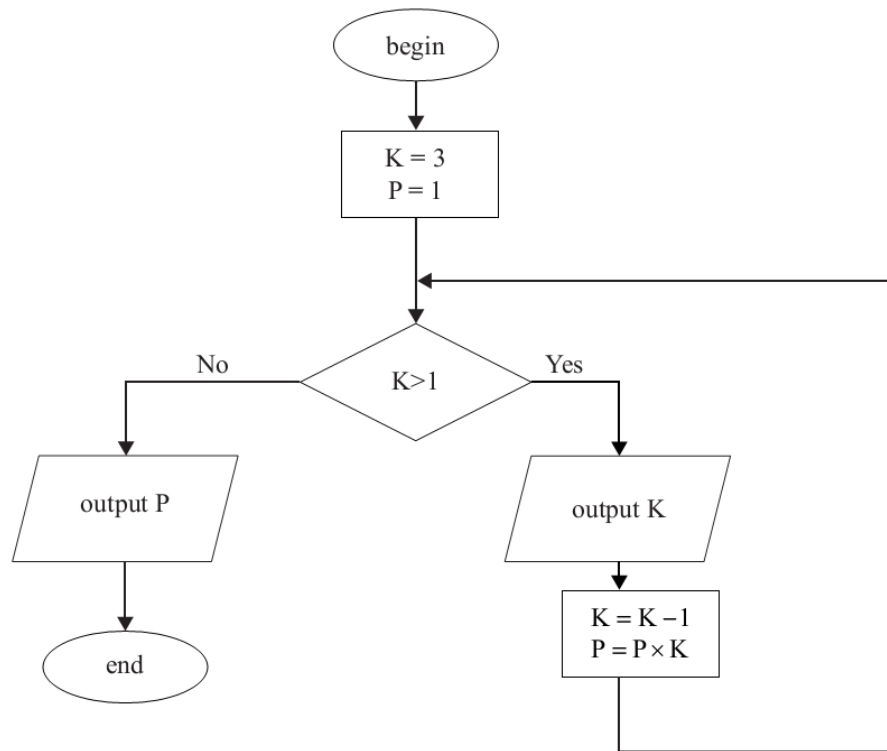


Example Questions for Trace table and Pseudo-code

Consider the following algorithm.



Trace the algorithm and show the outputs that will be produced.

[3]

Solution:

Award up to [3 marks max]. Award [1 mark] for each correct output.

K	K>1	P	output
3	true	1	3
2	true	2	2
1	false	2	2

Note: candidates are not expected to produce the whole trace table, only the outputs.

[3 marks]

Example Questions for Trace table and Pseudo-code

A *magic square* is a two-dimensional array with n rows and n columns in which each of the integers $1, 2, 3, \dots, n^2$ appears exactly once **and** all column sums, row sums and diagonal sums are equal.

The array A is a 7×7 magic square in which all rows, columns and the two main diagonals add up to 175.

A

	[0]	[1]	[2]	[3]	[4]	[5]	[6]
[0]	30	39	48	1	10	19	28
[1]	38	47	7	9	18	27	29
[2]	46	6	8	17	26	35	37
[3]	5	14	16	25	34	36	45
[4]	13	15	24	33	42	44	4
[5]	21	23	32	41	43	3	12
[6]	22	31	40	49	2	11	20

- (a) Construct an algorithm to calculate the sum of all elements on the main diagonal, from A[0, 0] to A[6, 6]. [2]
- (b) An array with n rows and n columns holds every number from 1 to n^2 . Construct an algorithm that checks whether the $n \times n$ array is a magic square. [8]

The following is the algorithm for constructing a magic square with n rows and n columns for any odd integer n .

- $Z = 1$
- Place Z in the middle of top row
- Loop until all integers $1, 2, 3, \dots, n^2$ are placed in the array
 - $Z = Z + 1$
 - Move one row up and one column to the right to place the integer Z, unless one of the following occurs
 - If a move takes you above the top row in the j^{th} column, move to the bottom of the j^{th} column and place the integer Z there
 - If a move takes you outside to the right of the square in the i^{th} row, place the integer Z in the i^{th} row at the left side
 - If a move takes you to an already filled square or if you move out of the square at the upper-right corner, place Z immediately below $Z - 1$.

- (c) By applying this algorithm, **copy** and complete the 5×5 magic square, which has been started below. Do **not** write solutions on this page. [5]

		1		

Example Questions for Trace table and Pseudo-code

- (a) Award **[1 mark]** for the correct loop.
Award **[1 mark]** for increasing the sum for the correct value.

```
S=0
loop for K=0 to 6
    S=S+A[K, K]
end loop
```

[2 marks]

- (b) Award marks as follows, up to **[8 marks max]**.
Award **[2 marks]** for correctly calculating sum of the second diagonal:
 [1 mark] for the correct loop and **[1 mark]** for increasing the sum for the correct value.
Award **[1 mark]** for a correct use of the Boolean variable, MAGIC.
Award **[1 mark]** for correct outer loop.
Award **[1 mark]** for correct inner loop.
Award **[1 mark]** for correct calculation of the row sum.
Award **[1 mark]** for correct calculation of column sum.
Award **[1 mark]** for comparing row sum and column sum with diagonal sum.

Example:

```
MAGIC= TRUE
SD1=0
SD2=0
loop for K=0 to 5
    SD1=SD1+A[K, K]
    SD2=SD2+A[K, N-K]
end loop
if SD1 != SD2
    MAGIC = FALSE
end if
K=0
loop while (K<=5) AND MAGIC
    SR=0
    SC=0
    loop for Z=0 to 5
        SR=SR+A[K, Z]
        SC=SC+A[Z, K]
    end for
    if (SR != SD1) OR (SC!=SD1)
        MAGIC = FALSE
    end if
    K=K+1
end while
if MAGIC= TRUE
    output "The array is a magic square"
else
    output "The array is not a magic square"
end if
```

[8 marks]

- (c) Award **[1 mark]** if the “off the edge” rule seen.
Award **[1 mark]** if the “off the top” rule seen.
Award **[1 mark]** if the “cell already filled” rule seen.
Award **[2 marks]** for whole square complete.

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

[5 marks]

Total: [15 marks]